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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/735,494	12/12/2003	Paul Douglas Yoder	51527/SAH/T539	1869

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EXAMINER

DICKEY, THOMAS L

ART UNIT	PAPER NUMBER
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2826

DATE MAILED: 02/10/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

**Application No.**

10/735,494

**Applicant(s)**

YODER, PAUL DOUGLAS

**Examiner**

Thomas L. Dickey

**Art Unit**

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 02 September 2004.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-35 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-25 and 27-35 is/are rejected.
- 7) ☒ Claim(s) 26 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 12 December 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

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## **DETAILED ACTION**

### ***Oath/Declaration***

1. The oath/declaration filed on 09/02/2004 is acceptable.

### ***Drawings***

2. The formal drawings filed on 12/12/2003 are acceptable.

### ***Priority***

3. Acknowledgement is made of applicant's claim for domestic priority under 35 U.S.C. 119(e), through provisional application 60/432,926 filed 12/12/2002.

### ***Information Disclosure Statement***

4. If applicant is aware of any relevant prior art, he/she requested to cite it on form **PTO-1449** in accordance with the guidelines set forth in M.P.E.P. 609.

### ***Claim Rejections - 35 USC § 102***

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

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(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

A. Claims 1-14, 19,24,25, and 27-35 are rejected under 35 U.S.C. § 102(b) as being anticipated by BARROU ET AL. (5,912,478).

With regard to claims 1-14 Barrou et al. discloses an avalanche photodetector comprising an InGaAs absorption layer 20, a multiplication region 14 including at least one multiplication layer having a bandgap about .475 eV different from the bandgap of the absorption layer 20 (Note that InGaAs has a bandgap of about .8 eV, while InGaAlAs, the material of the "well" multiplication layer, has a bandwidth of about 1.275 eV), and a graded transition region 16 between said absorption layer 20 and said multiplication region, said graded transition region 16 including a graded conduction band energy level (due to gradations in content) that produces a gradual change between a first conduction band energy level of said absorption layer 20 and a second conduction band energy level of said multiplication region.

With particular regard to claims 4-8 Barrou et al. further discloses that said graded transition layer is formed of In, Ga, Al and As (InGaAlAs) to form a film having a top facing said absorption layer 20 and a bottom facing said multiplication region and a ratio of Al:Ga varies gradually such that Ga concentration is maximized and Al concentration is minimized at said top so that said graded transition region 16 comprises essentially InGaAs at said top and InAlAs at said bottom; and Ga concentration is minimized and Al concentration is maximized at said bottom, and said InGaAlAs transition layer is a graded bandgap material in which a ratio of at least two cations (Ga and Al) of said

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InGaAlAs varies within said graded bandgap material, said absorption layer 20 is formed of InGaAs and in which said multiplication region 14 is composed of two multiplication layers being an InAlAs multiplication layer (part of layer 14, known to the art as a "barrier" layer) disposed closer to said graded transition region 16 and an InGaAlAs multiplication layer (part of layer 14, known to the art as a "well" layer) disposed further from said graded transition region 16 and further comprising a charge layer 17 formed of InAlAs and interposed between said graded transition region 16 and said InAlAs multiplication layer.

With particular regard to claims 3 and 9-14 Barrou et al. further discloses that said graded transition region 16 is formed of a quarternary InGaAlAs graded-bandgap material including at least two cations (Ga and Al) including molar fractions that vary throughout said quarternary material to effectuate a graded bandgap material, having a wider bandgap region closer to said multiplication region and a narrower bandgap region closer to said absorption layer 20, in which said graded transition region 16 includes a thickness within the range of 500Å to 0.4 microns and an un-biased effective electric field is defined as the difference of said first conduction band energy level and said second conduction band energy level divided by said thickness, and further comprising an applied bias applied across said avalanche photodetector, said thickness and said applied bias chosen such that said applied bias exceeds said un-biased effective electrical field by at least 20 kV/cm, further comprising a charge layer 17 made of InAl As so that it has essentially said second conduction band energy level and

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interposed between said graded transition region 16 and said multiplication region, said charge layer 17 including dopant impurities therein to produce an abrupt step in electrical field strength, and a power supply coupled to said avalanche photodetector and capable of providing a bias thereacross.

With regard to claims 19,24,25, and 27 Barrou et al. discloses an avalanche photodetector comprising an InGaAs absorption layer 20 having a top and a bottom, a multiplication region 14 disposed facing said bottom and including at least one multiplication layer (the various individual multiplication layers in region 14 are not numbered but are discussed at column 4 lines 20-24), said absorption layer 20 including a P-type impurity therein, and a P-type impurity concentration gradient such that said P-type impurity concentration decreases from said top to said bottom, an InAlAs charge layer 17 interposed between said absorption layer 20 and said multiplication region 14 and formed of substantially the same material as an InAlAs first multiplication layer (the various individual multiplication layers in region 14 are not numbered but are discussed at column 4 lines 20-24), disposed adjacent said charge layer, said charge layer including dopant impurities therein, an InGaAlAs second multiplication layer (the various individual multiplication layers in region 14 are not numbered but are discussed at column 4 lines 20-24), and a graded transition region 16 disposed between said absorption layer 20 and said multiplication region 14, said graded transition region being a graded-bandgap material, including a graded conduction band energy level that produces a gradual change between a first conduction band energy level of said

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absorption layer 20 and a second conduction band energy level of said multiplication region 14.

With regard to claims 28-35 Barrou et al. discloses an avalanche photodetector comprising an absorption layer 20, an InAlAs charge layer 17 including dopant impurities therein to produce an abrupt step in electric field strength, disposed next to said absorption layer 20, a first, relatively wide bandgap InAlAs multiplication layer (part of layer 14, known to the art as a "barrier" layer) disposed next to said InAlAs charge layer 17, closer to said absorption layer 20 and a second, relatively narrow bandgap InGaAlAs multiplication layer (part of layer 14, known to the art as a "well" layer) disposed further from said absorption layer 20, said first multiplication layer having a thickness of at least 0.1 microns, said second multiplication layer having a thickness of at least 0.1 microns, said first multiplication layer and said second multiplication layer having a combined thickness of at least 0.2 microns, said charge layer 17 thickness being no greater than 10% of said combined thickness; and further comprising a graded transition region 16 disposed between said absorption layer 20 and said charge layer 17, said graded transition region 16 being a graded-bandgap material including a graded conduction band energy level that produces a gradual change between a first conduction band energy level of said absorption layer 20 and a second conduction band energy level of said first multiplication layer, in which said absorption layer 20 includes a top and a bottom facing said multiplication region and includes a P-type impurity therein,

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said absorption layer 20 including a P-type impurity concentration gradient decreasing from said top to said bottom.

Note figures 1-4 and column 4 lines 10-55 of Barrou et al.

Claims 15-23 are rejected under 35 U.S.C. 102(b) as being anticipated by KUHARA ET AL. (6,218,684).

Kuhara et al. discloses an avalanche photodetector comprising an InGaAs absorption layer (marked "absorption layer" in figure 3) including a thickness within the range of 0.1 to 0.6 microns, having a top and a bottom, and a multiplication region (InP "buffer layer") disposed beneath said absorption region in which said x represents distance from said bottom, facing said bottom and including at least one multiplication layer, said absorption layer including a zinc P-type impurity therein, and a zinc P-type impurity concentration gradient such that said zinc P-type impurity concentration decreases from said top to said bottom. With respect to claims 15 and 22, the question is whether Kuhara et al.'s zinc P-type impurity concentration gradient is such that  $8 \text{ K eV /cm}$  ( $0.8 \text{ eV/micron}$ ) divided by  $kT \geq \partial \ln N / \partial x \geq 3 \text{ K eV /cm}$  ( $0.3 \text{ eV/micron}$ ) divided by  $kT$ , where k is the Boltzmann constant, T represents photodetector operating temperature in degrees Kelvin, q is the fundamental unit of charge, N represents said P-type impurity concentration, and x represents distance from said bottom. Note that, since 1 eV is the energy equivalent to a temperature of 11,604 degrees Kelvin and a cm is 10,000 microns, the formula is the same as 9,283.2 degrees Kelvin per micron, divided by the operating temperature of said photodetector  $\geq \partial \ln N / \partial x \geq 3,481.2 \text{ degrees}$



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Kelvin per micron, divided by the operating temperature of said photodetector in degrees Kelvin. The operating temperature is about 80 degrees Celsius (357 degrees K.), so that 3,481.2 degrees Kelvin per micron, divided by the operating temperature is 9.2 microns<sup>-1</sup>. 9283.2 degrees Kelvin per micron, divided by the operating temperature is 24.3 microns<sup>-1</sup>. The question, so complex sounding, therefore simply boils down (at a typical operating temperature of 80 degrees) to whether  $24.3 \text{ microns}^{-1} \geq \partial \ln N / \partial x \geq 9.1 \text{ microns}^{-1}$ . The answer, as may be seen from figures 3 and 4, is that the base 10 log of N (zinc, that is to say, P-type impurity density) changes by 3 in about 7/10ths of a micron. Thus the natural log (ln) changes by 6.9 in about 7/10ths of a micron, so that  $\partial \ln N / \partial x$  is about 9.85 microns<sup>-1</sup> and thus fits easily within the required range. Note figures 3 and 4 and column 6 lines 30-58 of Kuhara et al.

### ***Allowable Subject Matter***

6. Claim 26 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

### ***Conclusion***

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thomas L Dickey whose telephone number is 571-272-1913. The examiner can normally be reached on Monday-Thursday 8-6.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J Flynn can be reached on 571-272-1915. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

A handwritten signature in black ink, appearing to read 'T. L. Dickey', is positioned above the printed name.

**Thomas L. Dickey**  
**Patent Examiner**  
**Art Unit 2826**  
**02/05**